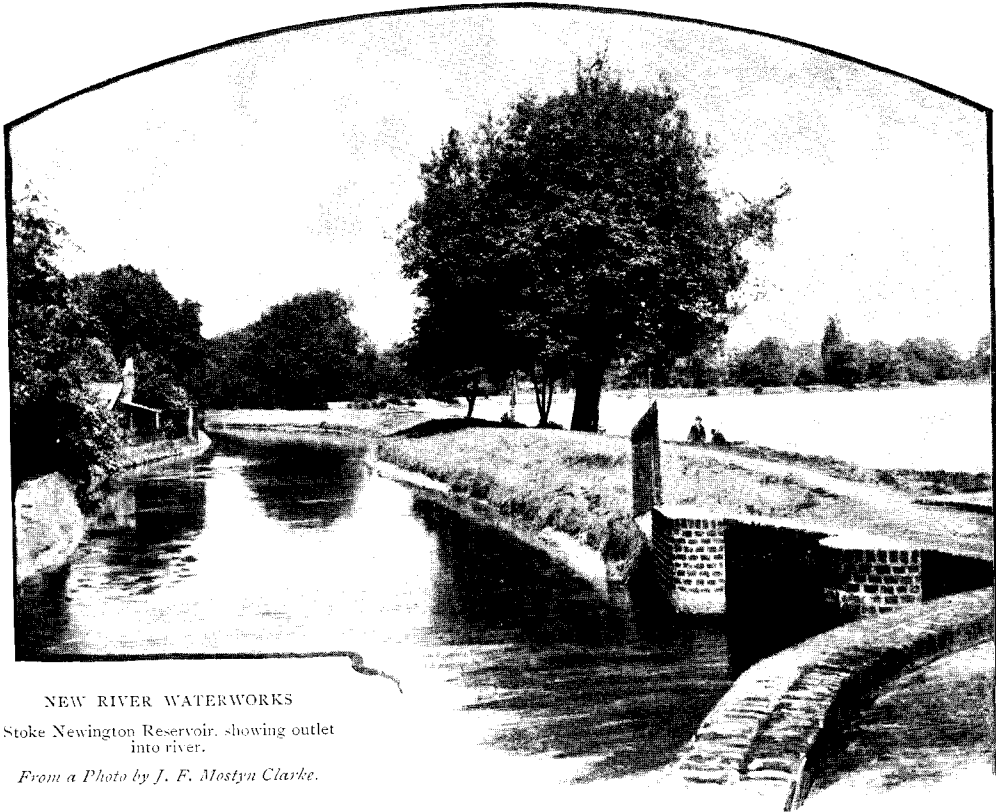


standing until the abolition of the old London Bridge in 1831. We may now conveniently glance at the history of each big company in turn.

The water-supply was at the end of the nineteenth century in the hands of eight private companies, whose 620 square miles of area comprised the whole of the Metropolis and parts of Middlesex, Herts, Essex, Kent, and Surrey. The oldest of these, the New River Company, originated in 1613, in the manner already described. The first shareholders were incorporated in 1619, under the



NEW RIVER WATERWORKS
Stoke Newington Reservoir, showing outlet
into river.

From a Photo by J. F. Mostyn Clarke.

title of "The Governors and Company of the New River brought from Chadwell and Amwell to London." The directorate was vested in twenty-nine persons, who held thirty-six adventurers' shares—so called in contradistinction to those held by the King and his assigns—which had originally belonged to Sir Hugh Myddleton, who at this time retained only two.¹ James I. did not live to receive any profits himself, and the thirty-six King's shares were afterwards resigned by Charles I.

¹ No particular area of supply was granted to the Company, and there was no limitation of capital in the Charter. A Select Committee of the House of Commons in 1821 stated the original cost to have been £369,600. Its capital in 1837 was £1,200,000; revenue £105,000; houses supplied, 73,000. The total income of the nine other companies then existing amounted in 1837 to £193,000.

in return for a yearly payment of £500, which the Crown receives to this day: a paltry sum when compared with the great value the shares were destined to possess at a later date. No dividend was paid till 1633. By the end of the seventeenth century each share of the New River Company was earning a dividend of about £200, and in 1890 a King's share was sold for £95,000. The Company was regulated by Acts of Parliament in 1738, 1739, 1767, 1779, 1805, 1822, and 1830, the last of which empowered it to erect two large impounding reservoirs at Stoke Newington.

When the New River Company absorbed the old London Bridge Waterworks in 1822 they undertook at the same time to supply water to all citizens whom the old Company had served, and to secure the then dividend to the original proprietors for two hundred and sixty years, namely, to the expiry of the lease of five hundred years which had been granted in 1582. Thus the New River Company were bound to pay £3750 per annum to the representatives of the original owners until the year 2082. Other undertakings bought by the Company were the Hampstead Waterworks, the North Middlesex Waterworks, and a private enterprise at Bush Hill Park.

The New River rises at Chadwell Spring, about a mile beyond Ware, in Hertfordshire. A short distance below this point the river is joined by a branch cut which conveys what became the main part of the Company's supply, namely the water from the River Lea. At first this supply was taken without let or hindrance, but after much litigation an arrangement was arrived at between the New River Company and the Lea Trustees whereby the amount of water to be drawn from the larger stream in the smaller was regulated. Originally the New River was 40 miles long, but short cuts over some of the valleys reduced the length considerably. The average quantity of water supplied by the Company is over 250,000,000 gallons of filtered water obtained from the River Lea, Chadwell Spring, and thirteen deep wells sunk into the chalk, and about 2,500,000 gallons of unfiltered water for other than domestic purposes from the same sources and from the Hampstead and Highgate Ponds. Surface water, which used to form a large proportion of the supply, has within recent years been as far as possible excluded from the river. The Company's district extends to 107 square miles, the actual area supplied is less than half, embracing the City and central London. Its boundaries may be described as, on the west, Charing Cross, Haymarket, and Hampstead Road, on the south the Thames, on the east the Tower and Stamford Hill, and on the north Southgate. The Company supply a population of 1,233,303.

2. The Chelsea Waterworks Company obtained their first charter from George I. in 1723, the result of an Act passed in the previous year for better supplying the City and Liberties of Westminster and parts adjacent. The scheme was to bring water from the Thames into canals and ponds, from which it was to be raised into

reservoirs between Oliver's Mount and Hyde Park. A royal warrant in 1726 authorised them to convert two ponds in St. James's Park into reservoirs, and another in 1727 authorised the construction of a reservoir in Hyde Park. The works were situated on the north bank of the river, and the water was drawn from the Thames direct and distributed in its polluted state to the consumers. In 1809, when they were raising 1,456,000 gallons daily, the Company were empowered to take water from the Thames near Ranelagh Creek, and to lay pipes in the river-bed for a distance of 240 feet in order to obtain water below low-water mark. The first attempt at purification was made by allowing the impurities to subside in settling reservoirs, but this did not prove effective. The first filter-bed in London was then introduced in 1829 by Mr. James Simpson, the Company's engineer, who had been instructed some years before to give his whole attention to this subject. The filter-bed was made of gravel and sand, and before being filled with water had the appearance of several channels parallel to one another, formed by banks broad at the bottom and gradually sloping on each side to a point at the top. It had brick sides, occupied about an acre, and was supplied by reservoirs having an area of about an acre and a half. First the water was pumped into the subsiding reservoirs; then, without disturbing the sediment, it flowed through small pipes to the filter-bed, where it soon percolated through the three strata of gravel and sand, which were each 2 feet thick and laid over brick tunnels. In 1852 the Company's intake was removed to Seething Wells, and new works were completed there in 1856, but, as the floods flowing into the Thames from the Mole regularly made the water turbid, the Company sought Parliamentary sanction in 1875 to remove the intake to a point higher up the river, about half a mile below Sunbury Lock, where, accordingly, new works were brought into operation in 1877. Two new filtered-water reservoirs with a total capacity of $11\frac{1}{2}$ million gallons were completed at Putney Heath in 1900, and the storage capacity of the reservoir at Molesey was increased 50 million gallons by the raising of its banks. The Company's district of $20\frac{1}{2}$ square miles is bounded on the north by Old Brompton Road and Knightsbridge, on the east by the New River Company's district, and on the south and west by the Thames. They supply a population of 285,249, and may take 22 million gallons daily from the Thames.

3. Lambeth Waterworks were established under an Act of Parliament passed in 1785 for supplying the inhabitants of Lambeth and parts adjacent with water from the Thames between Westminster Bridge and the confines of the parish of Christchurch. The works, containing an engine of only 20 horse-power, stood on Belvedere Road, close to the site where the footway over Charing Cross railway bridge now ends. One of the chief objects of the owners was to provide protection against fire, but in this respect they received no assistance from the all-powerful fire insurance companies. They had great difficulties to contend with at first owing to a large part of the district being below the ordinary high-water mark of the Thames.

Only 629 houses were on the first list of the supply, and no dividend was paid for twenty years, but the concern was controlled by far-seeing men who had no doubt of their ultimate success. In 1802 the area was extended to the "respectable and populous neighbourhood" of The Horns, Kennington. About 1810 the development of drainage led to a large increase of population in the Company's district, and the works had to be enlarged. By 1820 the wooden pipes were superseded by cast-iron ones. An open reservoir was erected on Streatham Hill in 1832, being served from the Belvedere Road Works, and two years later two large open reservoirs were



CLEANING OUT FILTER-BEDS, BATTERSEA (LAMBETH WATERWORKS)

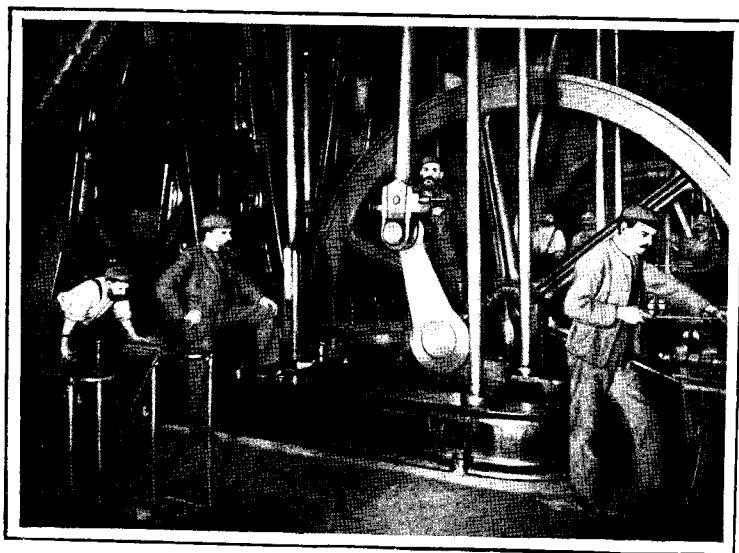
constructed at Brixton. The Company was reincorporated in 1848, and as the water became foul from the reception of sewage in the river they anticipated the Act of 1852 by removing their intake to Seething Wells. Their district was at the same time largely extended, and inhabitants who had been accustomed to buy water from carts at from $\frac{3}{4}$ d. to 2d. per pail, according to its quality, now had a proper supply laid on. Between 1854 and 1861 the Company made extensions to Dulwich, Forest Hill, and surrounding localities, consequent upon the increased population in those districts which followed the opening of the Crystal Palace. Kingston-on-Thames was brought into the Company's area in 1863, and an Act in 1871 added the outlying portions of Esher and East and West Molesey.

To the latter place the Company at the same time removed their intake, and used the gravel there as an additional source of supply. Almost every year witnessed new pipe extensions, and by 1900 the Company had powers to abstract $124\frac{1}{2}$ million gallons daily from the Thames. Their area is 103 square miles, of which 41 are in London, 56 in Surrey, and 6 in Kent. The district is bounded on the north by the Thames at Southwark, on the south by Claygate, on the east by Shortlands, and on the west by Molesey; and the population supplied is 729,234.

4. For the origin of the East London Waterworks Company we go back to the days of Shadwell Waterworks, originated by Thomas Neale, which in 1669 began to supply a large part of East London. Neale obtained a charter in 1687, and formed a company, and in 1681 the shareholders became a body corporate by letters patent. In 1747 George Montgomerie and others were empowered to supply Stratford, West Ham, and the Bow district with water, and a pumping station was erected on a branch of the River Lea. The London Dock Company purchased both those concerns in 1807, but in the same year an Act of Parliament established the East London Waterworks Company, who in 1808 were enabled to purchase them from the Dock Company. The East London immediately replaced the wooden pipes by iron ones, erected a pumping station at Old Ford, bought 30 acres on the banks of the Lea for reservoirs, and in 1828 were pumping 6,512,292 gallons daily. Hackney Waterworks and the Lea Bridge Mills were purchased in 1829, and about the same time the intake was removed from Old Ford to Lea Bridge, from which point the water was conveyed by a conduit to the storage reservoir at Old Ford and pumped thence for the supply of the district. In 1853 authority was obtained to make several new cuts in connection with the Lea, to construct large impounding reservoirs at Walthamstow and filter-beds at Lea Bridge, and to make an intercepting cut or canal on the westerly side of the Lea from Tottenham to beyond Ponders End in order to prevent any polluted water from entering the river above the intake. Parliamentary powers were granted in 1867 to establish works at Sunbury and Hanworth for supplying Thames water to the district, and in the same year the Company were compelled to discontinue the reservoirs at Old Ford, which were in the centre of an area affected by the cholera of the preceding year. An Act was passed in 1886 enabling the Company to make certain cuts and channels to Chingford and Walthamstow, and to sink wells. They have four sources of supply; first and largest the Lea, the intake being at Chingford; second, deep wells in the chalk at Walthamstow, Chingford, Old Ford, Lea Bridge, and Waltham Abbey; third, the Thames at Sunbury; and fourth, springs at Hanworth. They are empowered to supply an area of 139 square miles. On the north their district is bounded by Waltham Abbey, on the south by Stepney, on the east by Hog Hill, and on the west by Hornsey. By an Act in 1867 the Company were allowed to take 10,000,000 gallons daily from the Thames; by the end of the century the

powers had increased to 40,000,000. Additional reservoirs for their Lea supply were authorised in 1897, increasing the total reservoir capacity to 2,200,000,000 gallons; but a Bill in 1899 to enable the construction of further reservoirs containing 5,000,000,000 gallons was thrown out by the House of Lords. Partial failure of the East London supply, owing to the drought in 1898, impelled the Government to pass a Bill in the following year enabling the water companies to link up their mains and thus be in a position to render assistance to one another. The population supplied is 1,376,548.

5. The West Middlesex Water Company was incorporated in 1806 to further the scheme of an engineer named Dodd for supplying the West End. They erected at Hammersmith two steam-engines of 20 horse-power, and at a distance of one furlong



LAMBETH WATERWORKS. PUMPING ROOM

from the Thames two reservoirs to contain 1,333,000 gallons each, a brick tunnel being made from the river to the engine wells. The water was pumped from the wells into the reservoirs, where it was allowed to subside; it was then distributed by the same engines through 6-inch and 8-inch elm pipes. Soon the wooden pipes were discarded in favour of stone ones, which also had a short term, being replaced by cast-iron pipes in 1808. At Campden Hill a high-service storage reservoir was built. Competition against each other was so little palatable to the West Middlesex and New River companies, that in 1815 they agreed to amalgamate; but the Bill to effect this reform was ultimately abandoned, and each quietly pursued its independent course. At Barrow Hill, near Primrose Hill, the West Middlesex built a reservoir in 1825, which was partially filled from a well situated at a point opposite the road now called Wells Road. Water stood in this well at a level of 184 feet from the surface of the ground, but the supply proved so small that it was abandoned.

Subsiding reservoirs were built at Barnes in 1838, the water from them being conveyed to the engines at Hammersmith through a pipe laid in the bed of the river. When the Act of 1852 obliged the removal of the intakes to beyond the tidal limit, the West Middlesex selected Hampton as the best position for their works, and therefore relinquished Barnes in 1855. A special Act in 1866 limited the quantity to be taken from the Thames to 20,000,000 gallons daily, and extended the limits fixed by the Act of 1852 within which the Company can supply water. In 1886 the Thames Conservancy authorised them to take 24,500,000 gallons per day, though certain further powers were obtained in 1899. They are empowered to supply some 85 square miles, and the area which they actually supply stretches from Hendon in the north to Chiswick in the south, and from Acton in the west to Regent's Park in the east. Although for the first thirteen years the West Middlesex paid no dividend, and for many years afterwards only a small dividend, they were the first of the eight companies to pay the maximum dividend allowed by the law. They supply a population of 633,554.

6. Two histories have to be told in the case of the Southwark and Vauxhall Company. About the year 1771 an association was formed to provide a portion of the Borough of Southwark with water from a pond at St. Mary Overies. The property changed hands several times, and in 1820 came into the possession of Mr. Edwards Vaughan. Two years later this gentleman bought from the New River Company for the sum of £26,550 the part of the London Bridge Waterworks lying south of the Thames and supplying South London, and called his business here the Southwark Water Company. When Mr. Vaughan died in 1833 his representatives received Parliamentary sanction to sell the joint concerns, which were known as Southwark Waterworks, and, accordingly, they were disposed of to a new company in 1839 for £41,000. At first this Company obtained their supply of water from the Lambeth Company, paying £2400 annually for it, but when the Southwark Water Company Act of Incorporation of 1834 directed that the supply should be taken from the neighbourhood of Battersea, and filtered previous to delivery, the Company erected works there, which were completed in 1841.

Already, however, parts of South London were supplied by the Vauxhall Waterworks Company, originally established in 1804 as the South London Waterworks. This Company began to supply the inhabitants in 1807, but after six weeks its engine-house and wooden reservoir were burned down. The Company struggled on, obtaining power to raise further capital. The river water was taken from a brook at Brixton called the Washway, which flowed into the Thames at Vauxhall; concerning the jurisdiction over this brook there were frequent disputes. In 1828 the Company built auxiliary works at Cumberland Gardens, adjoining the foot of Vauxhall Bridge, including a 42-inch tunnel into the middle of the river, terminating 8 feet below low-water mark. Some of the water was pumped from the river into

the reservoir at Kennington Lane, but the bulk of it was taken direct from the channel at Vauxhall Creek. When, however, owing to the removal of Old London Bridge, and to the increasing accumulations at Vauxhall, the water from the Creek at neap tides became foul, the Company laid down in 1832 a large tunnel of pipes 48 inches in diameter to communicate with the inlet laid beneath the bed of the river, thus conveying the water directly into the Kennington Lane works. An Act of Parliament in 1834 extended the area of supply, and altered the name of the Company to the Vauxhall Water Company in order to avoid its being confused with the Lambeth and Southwark Companies. But, about the end of 1841, the affairs of the Company became involved, owing partly to the competition of the two rival companies, and partly to the expense of substituting iron for wooden pipes, and erecting more powerful machinery. In the session of 1843 two schemes were brought forward, having for their object the supply of the Vauxhall Company's district. Neither of these succeeded. At a meeting of the Company in December 1843 it was proposed to amalgamate with the Southwark Company; power to do so was granted in 1845, and the two Companies became one on October 1 of that year under the title of "The Southwark and Vauxhall Waterworks Company."

The engines at Cumberland Gardens, near Vauxhall Bridge, and at Kennington Lane were stopped in 1847, and the whole works were concentrated at Battersea. In accordance with the general Act of 1852 the source of supply was removed from Battersea to Hampton on July 26, 1855. About this time the Company began to supply the parish of Putney; in 1857, by agreement with the Lambeth Company, Wimbledon was taken in, and in 1861 they took over the district served by Richmond Water Company, whose works and plant they purchased at the instigation of the parish. Additional works were begun at Hampton in 1867 to meet increasing demand, and subsequent years witnessed repeated extensions, down to the making of six new filter-beds at the end of the century. In 1881 a deep well was sunk in the chalk on land acquired by the Company at Streatham. An arrangement was made in 1884 for obtaining water from the gravel-beds at Hampton, which, with the Streatham well, constituted sources of supply supplementary to that of the Thames itself. The intakes are on the north side above Hampton; the Company are empowered to serve $50\frac{1}{2}$ square miles, and the area of supply is bounded on the north by Southwark, on the east by Nunhead, on the south by Wimbledon, and on the west by Kew Gardens. By an Act of 1898 the Company were authorised to construct two additional reservoirs, and to take an additional quantity from the Thames. They may take 100,000,000 gallons daily from the river, and they supply a population of 833,125.

7. The Kent Waterworks Company dates from 1809, when it was founded to supply Deptford, Greenwich, Lee, Lewisham, and Rotherhithe. The Company bought for £65,000 the Ravensbourne Waterworks, which had existed since 1701,

consisting of pumping machinery driven by a water-wheel, by which the water from the Ravensbourne was distributed through wooden pipes. In 1811 they came to the rescue of the Town Commissioners of Woolwich, who had tried unsuccessfully for three years to provide a water-supply, and arranged to supply that town, purchasing for this object certain springs in the parish of Charlton. In 1857 the Company's first deep well was sunk in the chalk at Deptford, and so successful did their further efforts in this direction prove that the Ravensbourne was abandoned as a source of supply in 1862, since when the water has been drawn wholly from the chalk. The works of the Plumstead, Woolwich, and Charlton Consumers' Pure Water Company were acquired by the Kent Company in 1861, and in 1864 they absorbed the inactive North Kent Waterworks Company, whose district they began to supply three years later from deep wells sunk in the chalk at Shortlands and Crayford. The Company also acquired in 1868 the works of the Dartford Local Board of Health, which had been built in 1854, but had never been brought into use. In 1877 powers were obtained for supplying Cray Valley and the adjacent parishes, and for this purpose the Company sunk another well in the chalk at Farnborough in 1888, when parts of the Bromley and the Sevenoaks Rural Authorities' district were brought in for the first time. The Kent Company's district comprises the south-east of London, and extends from New Cross and West Wickham in the east to Swanscombe and Crockenhill in the west, and from Rotherhithe and Greenhithe in the north to Farnborough in the south. The total area they are empowered to supply is 212 square miles, of which only about one-sixth is in the county of London. They supply a population of 570,519.

8. The Act granted to the Grand Junction Canal Company in 1798 not only conferred powers for making a canal, but also for constructing works and laying down pipes for such a canal to supply water to Paddington. Those powers of supply, however, were transferred in 1811 to a new body, which, adopting the name of Grand Junction Waterworks Company, constructed works to the south of the canal basin and north of the road formerly known as the Grand Junction Road. The work was more expensive than the Company had anticipated, and the use at first of stone distributing pipes, which Mr. Rennie, the engineer, had advised, meant a great loss, as they had soon to be supplanted by iron pipes. The Company originally drew their supply from the Grand Junction Canal, whose sources were three in number, namely, the River Colne (a source suggested by Mr. Martin the painter), the River Brent, and a reservoir fed by the streams of the Vale of Ruislip. Owing to the pollution of the canal by land drainage, and to the foul character of the Brent, the Grand Junction Waterworks Company were obliged to abandon this source of supply. They then arranged to get water from the Regent's Canal Company, but the latter soon found that they could not afford to part with the quantity of water agreed upon. The quality of this supply, also, had been com-

plained of, and the Grand Junction Waterworks Company therefore in 1819 changed their source of supply to the Thames at Chelsea; an arrangement more precisely defined in 1826 in the Act which gave the Company enlarged powers and declared them to be a company for supplying water from the River Thames. A conduit was laid into the bed of the river, and through this the water was pumped by steam engines to the station at Paddington. The district supplied by the Company in 1830 consisted of Paddington and the area between Oxford Street and the Green Park. A large scheme of supply brought before Parliament by the Company (referred to elsewhere) was not passed. An Act passed in 1835 enabled the Grand Junction Company to take their supply from Brentford, 350 yards from Kew Bridge, which was at this time the highest point of intake of any of the metropolitan companies, and where the water was purer than that to be obtained in the direct vicinity of London. About ten years later the Paddington works, situated where Talbot and Norfolk Squares now stand, were removed to Campden Hill. In accordance with the Act of 1852 the Company removed their intake to Sunbury. It is now at Hampton. Their district was extended in 1861 to include Chiswick, Acton, and numerous other places, and in 1878 Heston and Hanwell and the previously-excluded parts of Ealing and Isleworth were brought in. The Company applied to Parliament in 1888 for power to acquire land at Dorney in Buckinghamshire, where they proposed to erect works with an intake from the Thames near Boveney Lock and a pumping station connected with Kew Bridge works by a line of conduit main; but the Bill did not pass. The principal trunk mains of the Grand Junction Company are connected with those of the West Middlesex, Chelsea, and East London Companies. They are empowered to supply an area of $52\frac{1}{2}$ square miles. Their district is bounded on the south by Hampton Court, north by Kilburn, east by St. James's Park, and west by Ealing and Sutton. They supply a population of 431,004, and are allowed to take $24\frac{1}{2}$ million gallons daily from the Thames.

The companies in existence before 1810 had obtained charters or Acts empowering them to make works and lay down pipes, and each company drew up a scale of charges to levy in its own district. But, when in 1811 powers of supply were granted to the East London, West Middlesex, and Grand Junction Companies, the long day of monopoly was legally ended, for the principle of the Acts under which these companies were created was the encouragement of competition. People at this time were wild for speculation, and the companies boldly fought an open fight in one another's hitherto appropriated territory. So intense became the fever of rivalry that it affected even the workmen who were engaged from morning till night in tearing open the streets for laying new pipes. But the companies were not slow to realise that this system was not likely to increase their profits, and an agreement in 1815

between the New River and East London companies was followed two years later by a pacific understanding among the companies supplying the western part of the Metropolis. The short-lived competition thus being brought to a close, virtual monopoly was established with a moral sanction stronger than before. The area of supply was partitioned among the companies, each withdrawing its services within a line agreed upon, and exchanging with another the pipes which had been laid down beyond its own boundary. From that time a great amount of public money was spent in Parliamentary inquiries and attempts to legislate upon the question of water-supply, but the only important measure effected down to the end of the century, apart from the Waterworks Clauses Act of 1847, was the one produced by the searching of heart which followed the cholera epidemic of 1849. The Board of Health had condemned the water-supply, and numerous improving Bills had been introduced and rejected, when in 1852 Lord John Russell's Government introduced a Bill prohibiting the companies from taking water from the tidal Thames, enforcing filtration, and providing for a constant supply and other reforms. The succeeding Administration (Lord Derby's) took up the Bill and passed it as the Metropolis Water Act, 1852. This Act was greatly beneficial to consumers, principally in compelling the companies to desist from taking water from within the tideway, and to resort to purer parts of the river above the lock at Teddington, which is the point beyond which the tide does not flow. The maximum dividend which any company could pay was fixed at 10 per cent, and one of the most useful provisions of the Act caused the companies to roof in every reservoir within a radius of 5 miles from St. Paul's Cathedral in which water was stored for domestic use, unless such water was subjected by the company to efficient filtration after it was discharged from the reservoir and before it was passed into the mains for distribution. Some hope was entertained that the new Metropolitan Board of Works, created in 1855, would have large powers with regard to water-supply, but, while they received power to purchase lands and water rights, the water which they could supply was to be neither for domestic, manufacturing, nor commercial purposes.

The tale of "agitation" and ineffectual attempts to improve the water and the basis of London water government is a much longer one than that of the actual legislation. When the competition among the companies collapsed in 1817 consumers complained bitterly of the increased price they were called upon to pay, in some cases amounting to as much as 25 per cent. An anti-water-monopoly association was formed, which held public meetings, and drew up petitions to be presented to Parliament. In 1818 the Select Vestry of Marylebone itself tried to pass a Bill for establishing a parochial water company, and this was followed by a similarly unsuccessful attempt by Mr. Michael Angelo Taylor to fix a maximum rate above which the water companies might not charge. At length in 1821

Parliament, before whose Select Committee in 1810 the water-supply had been proved to be scanty and precarious, again undertook an investigation, which, however, ended only by a report in favour of parliamentary control of the rates and an opinion that the supply was superior to that enjoyed by any city in Europe. A proposal was made in 1824 by Mr. Philip Taylor, engineer, to make a subterraneous aqueduct from the Thames near Richmond to convey water to a spot under Kensal Green, whence it was to be raised by steam power into a reservoir for common service; from this reservoir another subterraneous aqueduct was to continue to a spot near Hampstead Heath, and then the water was to be raised to a reservoir and used for high service. In the following year Mr James Mills proposed to bring Thames water for several miles above London by an open canal to an immense reservoir in Battersea Fields, whence all the companies were to take their supplies, but the project did not proceed. About the same time the Metropolitan Waterworks Company was formed to obtain a supply of pure soft spring water from beneath the blue clay about 35 fathoms deep; their Bill was abandoned after passing some of the stages. Among the attacks which were levelled against the companies particular attention was attracted by a pamphlet entitled "The Dolphin," published in 1827. The writer, a Mr. J. Wright of Regent Street, alleged that "the water taken from the River Thames between Chelsea Hospital and London Bridge for the use of the inhabitants of the Metropolis, being charged with the contents of more than 130 public common sewers, the drainings from dunghills and lay-stalls, the refuse of hospitals, slaughter-houses, colour, lead, gas and soap works, drug mills and manufactories, and with all sorts of decomposed and vegetable substances, rendering the said water offensive and destructive to health, ought no longer to be taken up by any of the companies from so foul a source." Now, although at this time the water of London was taken from the tidal portion of the river, it was still being delivered to consumers with hardly any attempt at filtration. But in 1828 a Royal Commission, appointed as a result of a West London petition presented by Sir Francis Burdett, advocated sand filtration for the removal of extraneous matter. The suggestion was adopted first by the Chelsea Company and afterwards by the others. This Commission at the same time recommended the companies to seek other sources of supply than the Thames, a suggestion which was soon confirmed by a Select Committee of the House of Commons. So far as filtration was concerned the result was not satisfactory, the quality of the water growing worse and chemical impurities remaining unaffected by sand or gravel. The Grand Junction Company applied in 1831 for powers to carry out a large scheme for supplying the whole of the Metropolis. The River Colne was to be deepened and embanked for several miles from its entrance into the Thames near Staines, and water was to be conducted through a canal 27 feet wide and $4\frac{1}{2}$ feet deep. Middlesex, Surrey, and part of Buckinghamshire were to be supplied. The

Bill, however, did not pass. A report on the best means of providing pure water was drawn up in 1834 at the instigation of Parliament by Mr. Telford, who recommended that the New River Company should go to the River Lea for an additional supply, and that at a cost of £1,777,840 the Grand Junction, West Middlesex, and Chelsea Companies should obtain their supplies from the River Verulam, and the Lambeth, South London, and Southwark Companies theirs from the River Wandle. A water inquiry conducted by a Committee of the House of Commons in 1834 was never finished, and a Committee of the House of Lords in 1840 contented themselves with taking evidence and laying it before their Chamber. Artesian wells were proposed in 1847: 140,000,000 gallons were to be provided daily from eighty wells to be sunk on the north side and forty to be sunk on the south side of the Metropolis. The fact that the water level of deep springs under London was showing a steady depression told against this scheme, and it dropped out.¹ A proposal to supply London by turning Richmond Park into a gathering-ground of surface water and shallow spring water, and another that the 10,000 acres of Crown land within 10 miles of the Metropolis should be converted into gathering-grounds, were considered by the General Board of Health, who, however, recommended finally in 1850 that the new supply should be taken from drainage of a tract of land 150 square miles in area formed by the Bagshot Sands and the lower greensands of Surrey. The Chemical Commission of 1851 reported favourably on the scheme of the London (Watford) Spring Water Company—which in the hands of the London and Westminster Water Company had been before the Lords Committee in 1840—to bring sufficient water from the springs under the chalk at Bushey Meadow to supply the north of London—the Bushey Meadow being 164 feet above high-water mark, the water could be conveyed to London without any cost beyond the actual cost of pipes, and the scheme was estimated to cost £400,000; and a proposal to supply South London at a cost of £150,000 from the chalk beds reposing on Wealden clay on 180 square miles of land between Blackheath and Higham. Meanwhile the habits of the riparian population were changing; a regular system of drainage supplanted the old cesspools, and the consequent sewage deposits in the river were further disturbed by the steam traffic which was now introduced upon its waters. Several other schemes were submitted to Parliament and rejected. One of these, introduced in the session of 1849, proposed to make a navigable cut from the Henley reach of the Thames to the Grand Junction Canal near West Drayton, to alter such canal and the Paddington Canal, and to construct reservoirs near Paddington and Primrose Hill. Another, introduced in 1850 on a petition of householders and ratepayers, proposed to bring a supply from the Thames at or near Mapledurham in

¹ There are hundreds of artesian wells in London; many breweries, hotels, and works have an independent supply from this source; but no returns or statistics exist to show how numerous these are, or what amount of water underground London yields them.

the county of Oxford. Two others were brought in during the same session, namely, the Metropolitan Waterworks (Henley-on-Thames and London Aqueduct) Bill and the London (Watford) Spring Water Company Bill. The Mapledurham Bill was stopped, and the others were defeated by majorities of about one hundred. Lord Grey's Government in 1851 introduced a Bill to consolidate the companies and place them under a Government department, the consolidated company to be guaranteed against any competition, and the dividend to be limited to 5 per cent until the rates were reduced to or below the fixed scale, after which it might be 6 per cent. The Bill was referred to a committee presided over by Sir James Graham, but was rejected, owing chiefly to the efforts of some seventy shareholders of the companies in Parliament. In the same year a Bill was introduced in the name of the people of London to give control of the supply to a representative body, but this too was thrown out.

An interval of calm succeeded these efforts, and meanwhile the advantages of the Act of 1852 were being felt, the companies spending on new works and alterations in the space of fourteen years no less a sum than £4,000,000.

At the period of the cholera epidemic of 1832, which caused 5275 deaths in London, sanitary science was almost an unknown branch of study, and only few facts were available by which to trace the spread of the disease. The circumstances were different when cholera again appeared in 1849, carrying off 14,125 persons, and also at the time of the visitation of 1854, when 10,708 persons died. The Report of the General Board of Health in 1850 showed that the epidemic had been propagated by the impure state of the water and by the defective appliances which existed in the poorer districts. An estimate made about this time by the Parochial Water Supply Association showed that a mass of impurity equal to 48,000 tons, condensed and increased by tidal agitation, was taken daily from the Thames and supplied to the inhabitants. The Chemical Commission of 1851 proved that drinking water had been largely the means of spreading cholera. "The contamination of sewage," said the Commissioners, "cannot fail to become considerable and offensive with the increase of population and the more efficient and general drainage of towns. And it appears to be only a question of time when the sense of this violation of the river purity will decide the public mind to the entire abandonment of the Thames as a source of supply, unless, indeed artificial means of purification be devised in the meantime and applied." The Medical Officer to the Privy Council, in his ninth report, dated March 31, 1867, stated that the predominant lesson derived from the outbreaks of 1849 and 1854 was that the localities of chief prevalence of the disease were mainly, if not solely, determined by the degree of impurity of the water-supply. The great field of activity of cholera south of the Thames in 1848-49 and 1853-54 was supplied by the Lambeth Company and the Southwark and Vauxhall

Company. In 1848-49 recipients of the Lambeth Company died at the rate of 12.5 per 1000, and recipients of the Southwark at the rate of 11.8. The deaths among the recipients of the Lambeth Company in the 1853-54 outbreak were only 3.7 per 1000, the salutary reduction being attributed to the fact that the Company had shortly before removed its source of supply from Hungerford Bridge to a point higher up the river, at Ditton; but the deaths among the recipients of the Southwark supply during the epidemic were as many as 13 per 1000, and this company also soon began to take its water from a purer part of the Thames than Battersea. Regarding the cholera of 1866 the same medical officer traced the outbreak to the impurity of the East London Company's supply from their reservoir at Old Ford. "The area of prevalence," he said, "approximated with remarkable closeness to a particular field of water-supply, and there are facts which seem to prove that this approximation was not accidental. It is known that immediately prior to the outbreak in the east districts of the Metropolis and neighbouring districts across the Lea, impure water was distributed over this field of supply, and it is highly probable that this water was charged with choleraic poison." The Thames Conservancy Board were empowered in 1866 to prevent the fouling of the river, and in 1867 an Act was passed to facilitate the disposal of sewage by means of land irrigation, but these powers were not fully utilised by the towns affected on the upper reaches of the Thames. An Act passed in 1868 made provisions for the Lea similar to those made for the Thames two years before. Another source of choleraic poison was a number of surface wells and pumps yielding water at once the brightest and the deadliest. The most dangerous of these was the Broad Street pump, near Golden Square, which caused death to those who used it during the cholera epidemic of 1854.

Numerous schemes were submitted to the Royal Commission which sat on the question between 1867 and 1869. Mr. J. F. Bateman, engineer of the Glasgow, Manchester, and Thirlmere Waterworks, proposed to derive the supply from a total area of about 204 square miles on the tributaries of the upper parts of the Severn above Welshpool, Newtown, and Llanidloes, known as the Vyrnwy, Banwy, Carno, Tyrannon, Clywedog, Tylwch, etc. He proposed to obtain 230,000,000 gallons per day, which could be increased if necessary to 300,000,000, and to convey it to London in a conduit starting at a level of 450 feet above the sea. The scheme was estimated to cost £11,400,023; the water was of good quality, and Liverpool afterwards secured a supply from one of the above streams, namely, the Vyrnwy. Mr. H. H. Fulton projected a scheme for taking water from the Upper Wye. The district above Hay, Builth, and Rhayader, extending to the slopes of Plynlimmon, would, he calculated, yield 393,000,000 gallons per day, but he only proposed to bring 230,000,000 gallons, at a cost of £9,000,000. Mr. George Remington proposed to bring 100,000,000 gallons per day from the hills of Derbyshire for

£5,000,000; Mr. M'Clean proposed to embank and canalise the Thames above Medmenham so as to form a long series of impounding reservoirs in the channel of the river, from the lowest of which he would bring 200,000,000 gallons per day, the scheme to cost £1,500,000; Mr. Bailey Denton proposed, for a cost of £5,320,000, to purchase the Thames and Severn Canal and the North Wiltshire Canal, and to take from the Thames and these tributaries all the water required, storing the surplus waters of the winter season in order to repay the river system in summer; Mr. Brown, of Cirencester, proposed that the Upper Thames district should supply water for drinking purposes only to the extent of from 6,000,000 to 9,000,000 gallons, and that the supply should be conveyed to London by pipes along the Great Western Railway; Mr. Bravender, of Cirencester, proposed to collect water in the valleys of the Churn, the Colne, the Windrush, and the Ock, and convey it by a conduit pipe to London; Mr. Mylne proposed at a cost of £1,250,000 to bring an additional supply of 70,000,000 gallons per day from the Lea, making the drainage area better available by collecting the streams and chalk springs into impounding reservoirs; while Mr. Thomas Hennell proposed to bring an additional 14,000,000 gallons per day from the Basingstoke Canal and from sources adjacent to it at a cost of £280,000, including the purchase of the canal. Mr. G. W. Ewens suggested going to certain springs in the chalk between Emsworth and Bedhampton near Chichester. Mr. Telford M'Neil proposed at a cost of £6,000,000 to obtain 200,000,000 gallons per day by intercepting water from the Thames at Teddington, raising it 200 to 380 feet, and conveying it in an open channel to the Bagshot sands, through which it should filter, thence it was to be conveyed in a closed conduit to London and again pumped into reservoirs at Norwood and Hampstead. Mr. Homersham, Mr. P. W. Barlow, and Mr. R. Meeson brought forward proposals for supplies from the chalk-formations in the basin of the Thames. Mr. G. W. Hemans and Mr. Richard Hassard proposed to bring 287,000,000 gallons per day from the lakes Thirlmere, Ullswater, and Haweswater at a cost of £13,500,000—thirty years later Thirlmere was appropriated by Manchester.

The above schemes were rejected by the Royal Commission on various grounds, an objection to certain of them being that the experience with plans for supplying large towns with water by gravitation from catchment reservoirs formed in hilly districts had not then been so extensive as to enable engineers to make accurate calculations, in all cases, as to their efficiency. Moreover, the Commissioners were satisfied with the capacity of the existing sources of supply; and as to quality, they believed that when efficient measures were adopted for excluding the sewage and other pollutions from the Thames and the Lea, and their tributaries, and for ensuring perfect filtration, water taken from these sources would be perfectly wholesome. They were in favour of the widest possible extension of the system of constant supply, and not being able to see how this could be effectually introduced

as long as the supply remained in the hands of private companies, to whom it would be inexpedient to confide the great powers necessary for the purpose, they recommended that the future control of the supply should be vested in a responsible public body, which should levy two rates: one for a domestic supply for dwelling-houses, and a general one on the value of property. Mr. Shaw Lefevre accordingly introduced a Bill in 1870 providing for placing the companies under the control of the Metropolitan Board of Works, giving the latter power to regulate supply, to prevent waste, and also to purchase and acquire the interests of the companies, but the Bill was withdrawn in the face of the opposition it encountered from the companies. The Report of the Royal Commission was given effect to, however, in the Metropolitan Water Amendment Act, 1871, which provided for constant supply, the introduction of the public audit of the companies' accounts by the Board of Trade, and the appointment of a permanent water examiner.

A constant service to the inhabitants had been a subject of protracted discussion. As early as 1847 the Waterworks Clauses Act had endorsed the principle, but the adoption of the constant-supply system was optional, and the companies neglected it. The Act of 1852 compelled them to provide such a supply when four-fifths of the inhabitants, having the requisite appliances, made written application: but no application of the kind was ever sent in. On week-days the supply was available only for a few hours. On Sundays in many districts no water was supplied at all, while in others it was common for the inhabitants to be thankful when a fire occurred in their neighbourhood, because the fire-engine being thus brought to their doors they had an opportunity to lap up water from the roadway. In the City itself in 1850 there were 505 houses which had no separate supply but were dependent on stand-pipes or common cocks, where the citizens attended in crowds, pail in hand, at a fixed hour each day; and sixty-five houses which had a separate supply but were without cisterns; making altogether 570 out of the 16,300 houses within the City which were without fixed receptacles for storing water between the hours of daily supply. Dr. Horace Jeaffreson, who was resident medical officer to the fever hospital, made in 1865 a house-to-house inspection of the worst quarters of Lambeth, St. George's, Southwark, Bermondsey, Rotherhithe (a district which had no public supply until 1843), Bethnal Green, St. Luke's, Middlesex, St. Pancras, and St. Giles, and he found the water in those typhus nests extremely deficient. "Those houses the best supplied," he reported, "have each a butt holding about eighty gallons, into which water flows from a stand-pipe for from ten minutes to half an hour each day, and is supposed to supply the wants of twenty persons for cooking, the washing of their persons, house and linen, and for the rinsing down of the water-closet at such times as it may appear to suit the caprice of any one of the inmates. At other places a

larger butt, but in relation to the number of persons proportionally smaller, supplies a whole court of ten or more three-roomed houses which have no backyard and a population of 150 people—members of thirty different families. On Sundays even this supply is absent, the water of the day before is gone, and in many houses that for the Sunday cooking has to be begged from neighbours who may have provided themselves with a larger butt, who are more provident, or more dirty. Sometimes for part of Sunday and Monday the whole court has to borrow for their scant necessities from a 'pub' at the corner" (see p. 268). A Select Committee of the House of Commons who inquired in 1867 into the results of the Act of 1852 recommended that the Act "should be amended by providing that every company should afford a constant supply of water to each house, so that the water may be drawn direct from the company's pipes at all times during the twenty-four hours." We have seen that the Duke of Richmond's Royal Commission in 1869 urged that the constant service ought to be introduced promptly to the farthest extent possible, that in 1870 Mr. J. Shaw Lefevre brought in a Bill providing for a constant supply and other radical changes, and that, in the following year, this Bill was withdrawn. A substitute measure, less drastic, then passed as the Metropolis Water Amendment Act, 1871, and secured for the inhabitants a constant supply under certain conditions, as well as an official analysis of the water. No company could be required to give the constant supply, however, if it could be shown that more than one-fifth of the houses in the district for which it was wanted were not provided with the prescribed fittings. Regulations in accordance with the provisions of the Act were framed by the companies, but the Metropolitan Board concluded that constant supply subject to such difficult regulations would be worse than the existing state of things, and even when the Board of Trade had drafted a set of modified regulations the Metropolitan Board reported that these were so "stringent as to render it extremely improbable that the system of constant supply provided for by the Act of Parliament can ever be brought into general operation whilst such regulations are in force." It remained for the conscience of the companies themselves to impel the reform, and the East London was the first to do so by introducing a constant supply to 6273 houses in the parishes of Bethnal Green and Shoreditch. One by one the other companies fell into line, with the result that 666 of the 3000 to 4000 miles of mains in London at the end of the year 1874 were constantly charged. In 1881 there were on the constant-supply system 397,441 houses, equal to about 53 per cent of the whole number of houses supplied with water. Soon after the County Council was created in 1889 they discovered that only 423,567 of the 784,733 houses in the county were getting a constant supply, and by March 1894, as the result of negotiations carried on with the companies, this number had been increased to 613,187. By the end of the century 867,227 houses, or about 95 per cent of the whole number, were on constant supply. The average daily supply of water per head of the

population in 1829 was 23.3 gallons, in 1856 it was 33, and in 1900 a population of 6,092,536 was supplied with about 36.72¹ gallons per head daily. In 1852 the amount of water which the companies might take from the Thames was 100,000,000 gallons daily; in 1900 it was 435,000,000 daily, including the 100,000,000 which the Staines Reservoirs Joint Committee were authorised to abstract. The Staines Reservoirs Act, 1896, had enabled the companies to increase their supply by means of storage reservoirs at Staines, and by drawing an additional supply of 35,000,000 gallons daily from the Thames. There is no restriction on the amount which may be abstracted from the Lea. The total of 77,397,748,495 gallons supplied by the companies in 1900 meant in round figures a daily average of 212,000,000 gallons, of which about 120,000,000 were drawn from the Thames, 50,000,000 from the Lea, and the rest from springs and wells. From the last-named source, of course, the purest water was derived, analyses of the Local Government Board showing that the proportion of organic matter in samples from the deep wells of the Kent Company was only 0.7 compared with from 1.6 to 2.8 in the case of the Lea, and 2.9 to 3.3 in the case of the Thames.

We have seen that the Royal Commission of 1869 believed that with adequate filtration the water which London was receiving was wholesome. The quality of the water, however, wholly failed to satisfy the Royal Commission on the Pollution of Rivers, who, in their report in 1874, recommended the abandonment of the existing sources of supply for domestic purposes. The water of the Lea, they said, was less impure than that of the Thames, but the Lea also should be abandoned, as the water was deteriorating in quality from year to year, and there was no hope of purifying it to such an extent as to render it at all times safe for domestic use. On the other hand the Commissioners recommended an extended supply from the existing deep wells in the chalk, and from similar sources in the Thames Basin; and they advised that the control of the water-supply should be transferred to a responsible public body. A recommendation that the water systems should be consolidated in the hands of a public authority also came from a Committee of the House of Commons which in 1877 inquired into the conditions of the supply for extinguishing fires—an aspect of the question which had become acute twelve years previously when the Fire Brigade was taken over by the Metropolitan Board of Works. In the session of 1878 this Board introduced two Bills which were part of one complete scheme: the first providing for the purchase of the companies, the second for obtaining at a cost of £5,500,000 a daily supply of about 16,000,000 gallons of pure spring water for drinking and dietetic purposes by means of wells

¹ That is, including for domestic and other purposes. For domestic purposes only, the average daily supply in 1900 was 27.84 gallons per head of the estimated population. The hardness, on Clark's scale, of water derived from the Thames, Lea, and Chalk Wells varies from 15 to 22 degrees.